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PHYSICOCHEMICAL MECHANICS OF MATERIALS (SELECTED
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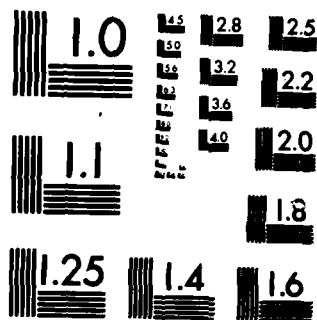
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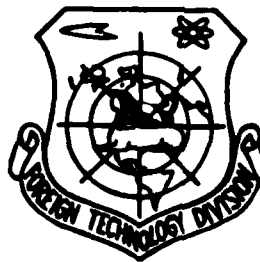
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PHYSICOCHEMICAL MECHANICS OF MATERIALS
(Selected Articles)



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EDITED TRANSLATION

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З з	<i>З з</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

*ye initially, after vowels, and after ъ, ы; e elsewhere.
When written as ё in Russian, transliterate as yě or ě.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh ⁻¹
cos	cos	ch	cosh	arc ch	cosh ⁻¹
tg	tan	th	tanh	arc th	tanh ⁻¹
ctg	cot	cth	coth	arc cth	coth ⁻¹
sec	sec	sch	sech	arc sch	sech ⁻¹
cosec	csc	csch	csch	arc csch	csch ⁻¹

Russian English

rot curl
lg log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

This report includes the following articles:

1. THE PROBLEM OF THE CLASSIFICATION OF STRESSES IN REINFORCED PLASTICS -

V. F. Sarabeyev, S.M. Perlin, G. K. Shreyber

— No clearly-defined classification of stresses arising in the area of reinforced plastics exists at the present time. These stresses have the most diverse types of names: internal, residual, initial, intrinsic, thermostructural, structural, optical. When becoming familiar with the research done by investigators of different schools, it is difficult to know precisely which stresses they are speaking of. In our opinion, it is expedient to make use of only two terms: transient stresses and residual stresses. Stresses disappearing in a material, stock, or structure after elimination of the causes of their arising must be called transient stresses. Residual stresses are those which are maintained after the removal of the causes of their appearance [1,2] As for the term "internal stresses" which is often encountered in the literature, this has no meaning because all stresses are in essence internal, and only loads, strains, and forces can be external. The present article

cont'd pg. 5

constitutes an attempt to classify stresses arising in reinforced plastics.

It is known [2, 3] that stresses can arise in all stages of the technological process even without the application of external forces (unequal heating and cooling, structural or phasal change, etc.). From the viewpoint of the history of their appearance, (with respect to genesis) these must be called genetic transient stresses or residual stresses. The reasons for the arising of genetic stresses are the differences in the chemical and physical properties of the components of a material (or of the starting substances). Among these are: the presence or absence of adhesive between components; change in volume due to different structural changes (chemical shrinkage); difference in the thermal expansion coefficients of the components (physical shrinkage); difference in the thermal conductivity and heat conductivity coefficients, the heat transfer coefficients of the external and internal layers or components of the materials; and the technological stress of the reinforcing elements, and other technological factors.

Genetic residual stresses, can, in turn, be divided into micro-, and submicro- stresses depending on the area in which they are balanced.

Macro stresses encompass the entire volume of a product or a considerable part of it and are balanced within a single order with the volume of the product. They can be revealed when cutting a body into sections and measuring the deformation (e.g., [illegible]), and also be studied directly in the majority of transparent plastics using an optical polarization method [4] using the band pattern (isochrome and isocline) corresponding to the stress state of the product, which is in question. The appearance of genetic

residual macrostresses is caused by a difference in the heat conductivity and thermal conductivity coefficients in the different layers of a material, and also by chemical shrinkage covering a considerable volume. Macrostresses (or at least the vast majority of them) can be eliminated using pressing. There is no possibility of genetic residual stresses upon a slow cooling of a material after pressing because what occurs here is a leveling off of the difference between the layers possessing approximately the same properties. Therefore, the behavior of the different layers upon a slow cooling is identical. Macrostresses are typical of reinforced materials and unreinforced materials.

Microstresses occur on the boundary of the reinforcing element-binder, and encompass a portion or the entire volume of each individual element, and part or all of the enclosing or connecting element, by becoming equalized in these very areas. Microstresses cannot be discovered when a body is broken into parts. Direct study of them when using optically transparent resins is possible using a topical-polarization method on models as well. The principal reason for the occurrence of genetic residual microstresses is the difference in the heat dispersion coefficient of the different components of the material upon a difference in the caliche of the adhesive between them. It is not possible to get rid of a microstress by annealing; although, at annealing temperature, equalization of them does occur, upon subsequent cooling they re-appear, because the different components behave differently in accordance with the thermal dispersion coefficients. Microstresses in the transverse section of a product have sharply different peaks which correspond to the compressed and distended state of glass and of a binder. Microstresses are distributed in the entire volume of a product, including the

reinforcing elements.

Submicrostresses occur between the individual chains or rings of a single macromolecule, and encompass the volume of one or several macromolecules of a binder or the volume of one or several molecules of a reinforcing element during its amorphous structure. These stresses can be gotten rid of in reinforced plastics by annealing in the corresponding regime. The principal reason for genetic residual submicrostresses is the various structural changes of the components of the material being produced.

Such a classification of genetic stresses is identical with the one proposed by N. N. Davydenkov [5]; geometric and X-ray criteria serve as the basis for it to the same extent. X-ray criteria can not be adopted for classification of genetic stresses in reinforced plastics, because the binders and glass fibres of the usual structures which are most often used when reinforcing plastics do not possess a crystal lattice as a rule.

LITERATURE

1. И. А. Биргер, Остаточные напряжения, Машгиз, 1963.
2. Машиностроение, Энциклопедический справочник, т. I, кн. 2, т. 3, М., 1947.
3. Н. Н. Гвоздов, Основы теории упругости, пластичности и ползучести, Изд. «Высшая школа», 1964.
4. М. Фригт, Фотоупругость (поляризационно-оптический метод исследования напряжений), т. 1, 2, ОГИЗ, ГИТТЛ, 1948, 1950.
5. Н. Н. Давыденков, ЗЛ, 1960, № 7.

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5. INVESTIGATION OF THE CREEP OF A POLYCARBONATE IN CORROSIVE ENVIRONMENTS —

V. N. Kestel'man, L. N. Magazanova, R. A. Denisova, Yu. I. Anosov

The polycarbonate is one of the new polymeric materials promising for industry, but its physical and mechanical properties and its exploitation properties have not been sufficiently studied yet. Macrolon (West Germany) and Diflon K (USSR) polycarbonates are used in Soviet industry. We raised the problem of investigating the creep and the long-term stability of Makrolon and Diflon K in corrosive environments.

It is known that, according to the theory on linear viscosity, a body is examined as combination of elastic elements complying with the Hooke law, and a type of damper complying with the Newton law [1, 2]. Complete creep deformation is separated into instantaneous elastic deformation ϵ_0 independent of the time parameter, highly elastic deformation ϵ_{B} , and plastic deformation ϵ_{r} , which are variable in time:

$$\epsilon(i) = \epsilon_0 + \epsilon_{\text{B}} + \epsilon_{\text{II}}.$$

The region of creep being established is most essential for industrial calculations when using polymers because, first of all, its time interval is considerably greater than in other creep stages, and secondly, because a region of growth in the creep rate and of destruction of the polymer follows immediately after it. Therefore, investigators pay most attention to an experimental study and to a mathematical description of precisely the creep in a specific system.

As specimens of polymers for the investigations, castings were obtained under pressure in technological systems which were determined as being optimum during reprocessing on a KIASY [expansion unknown] device [3]. The creep was investigated using two methods. In the first method, wire tensometers were glued onto the surface of brick-shaped specimens with a size of 15 x 10 x 120 mm. In order to calculate the value of the stresses occurring on the surface of the product under investigation, a modulus of longitudinal elasticity E , and the Poisson coefficient μ of the material were determined first of all, using a Gugenburg tensometer. The experiment indicated that the longitudinal deformation of Makrolon amounts to $\epsilon = 2.4 \cdot 10^{-3}$ while the transverse deformation $\epsilon' = 0.95 \cdot 10^{-3}$. The Poisson coefficient of the Makrolon is equal to 0.396, while the modulus of elasticity $E = 2.43 \cdot 10^4$ kg/cm².

For evaluation using a tensometer and stress method, a C scale was determined by calibrating the tensometers on a beam-type specimen made from a polycarbonate. Detectors with a base of 10 mm and a resistance of 91.6 ohms were used. Using the tensometry method, we studied the creep of a polycarbonate during stretching, compression, and bending at a temperature of 20° C. Bars of Makrolon and Diflon K were tested for creep in the initial state as well as after 70 days of holding in the corrosive environments - 28% solutions of

nitric, hydrochloric and sulfuric acid and in 40% glacial acetic acid. The physical and mechanical properties and the chemical properties of the polycarbonates were measured after holding the in corrosive environments. Thus, the long-term effect of the acids lead to a decrease in molecular weight, an increase in the the dimensions of the spherulite formations, and a decrease in stability and deformativity [4].

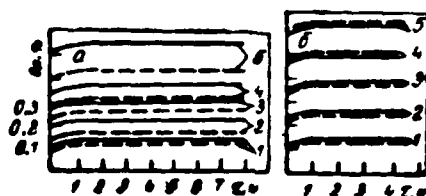


Fig. 1 Curves of the creep of Macroton (dotted lines) and of Diflon K (solid lines) upon stretching in air up until (a) and after (b) holding in nitric acid at the following tensions: 1 - 25 kg/cm²; 2 - 50; 3 - 75; 4 - 90; 5 - 130 kg/cm².

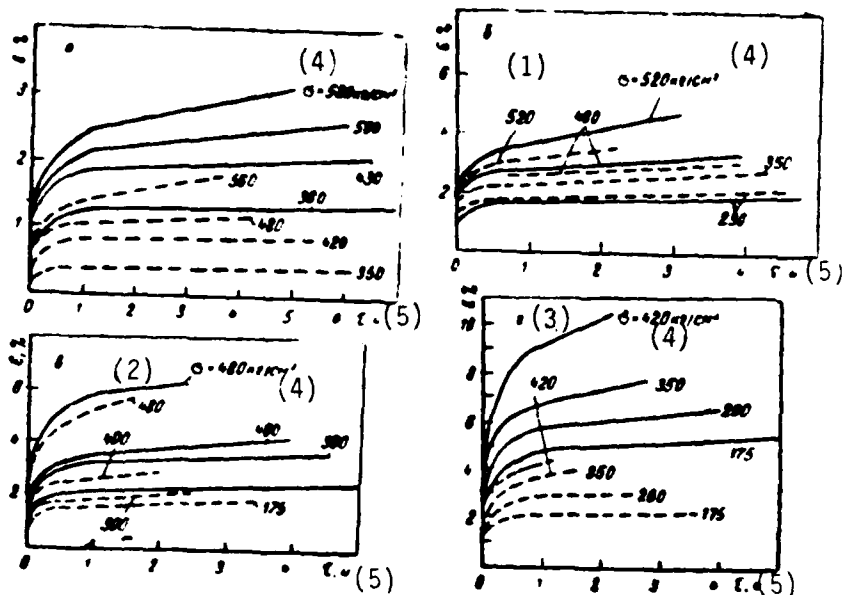


Fig. 2 Curves of the creep of Macrodon (dotted lines) and of Diflon K (solid lines) upon stretching in water at various temperatures: a - 40° C; b - 60; c - 80; d - 95° C.
Key: (1) b; (2) c; (3) d; (4) kg/cm²; (5) time, hours

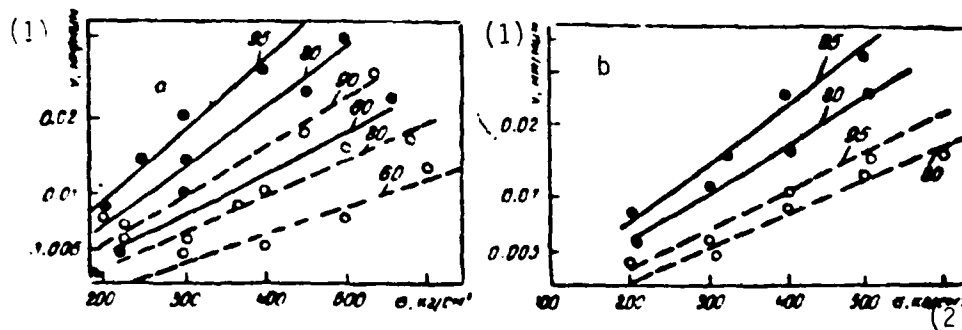


Fig. 3 Dependence of rate of creep of Macrodon (dotted lines) and of Diflon K (solid lines) on stretching values: a - in water; b - in citric acid.
Key: (1) v , mm/mm·m; (2) σ , kg/cm².

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